THE USAF AND TECHNOLOGICAL ASYMMETRY:
A Critique of Current Air Power Theory and Doctrine

A Monograph
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The analysis shows that the USAF is over-reliant on technological asymmetry. The current air power theory and doctrine of strategic attack requires technology to replace some aspects of human decision making, technology to replace strategy (to a degree), the elimination of fog and friction, and certainty regarding enemy reactions in order to be effective. These assumptions, which are the foundation of the theory, require careful and rigorous examination — which the Air Force has not yet accomplished. Over-reliance on technological asymmetry raises fundamental concerns, and USAF thinkers must address these concerns in order to make the theory and doctrine truly viable.

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ABSTRACT

THE USAF AND TECHNOLOGICAL ASYMMETRY: A CRITIQUE OF CURRENT AIR POWER THEORY AND DOCTRINE by MAJ Karen S. Wilhelm, USAF, 55 pages.

This monograph examines the question of whether the United States Air Force (USAF) is too reliant upon technological asymmetry. It examines four possible paths to over-reliance and then surveys Air Force doctrine and air power theory. The study then assesses that doctrine and theory in light of potential over-reliance on technological asymmetry.

The analysis shows that the USAF is over-reliant on technological asymmetry. The current air power theory and doctrine of strategic attack requires technology to replace some aspects of human decision making, technology to replace strategy (to a degree), the elimination of fog and friction, and certainty regarding enemy reactions in order to be effective. These assumptions, which are the foundation of the theory, require careful and rigorous examination - which the Air Force has not yet accomplished. Over-reliance on technological asymmetry raises fundamental concerns, and USAF thinkers must address these concerns in order to make the theory and doctrine truly viable.

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INTRODUCTION

The search for military victory is ultimately a search for asymmetry. In the opening chapter of the opening book of On War, Clausewitz poses the analogy of the wrestler trying to throw his opponent as a description of war.[1] The wrestler tries literally to create an imbalance, an asymmetry, in order to win the match. In the same way, the opposing sides in battle try to create asymmetries in order to win the war.

Asymmetry is defined as "not identical on both sides of a central line; lacking symmetry," not proportional, imbalanced.[2] It is a useful concept in analyzing warfare because proportional or balanced forces lead to protracted war or stalemate. Thus, in preparing to meet an enemy, a focus on creating asymmetries can lead to quicker, more decisive victory.

This study assumes that the objective of military forces is to create asymmetry at one or more of the three levels of war - tactical, operational, strategic. Military forces create tactical, operational, and strategic asymmetries by creating what may be termed "subordinate asymmetries." A combatant may create or have the benefit of technological asymmetry. For example, the European powers were able to defeat large numbers of native warriors in their colonies primarily because of their technological advantage in weaponry.[3] There can be asymmetries in doctrine, or degree of commitment to the fighting. Various factors may create

psychological asymmetry between the combatants. Finally, asymmetry may exist in the degree of proficiency of the soldiers (training), or in sheer numbers.

The German conquest of France in May-June 1940 provides an example of the interaction of these subordinate asymmetries. The two sides were technologically symmetrical. The Germans achieved doctrinal asymmetry by employing their forces differently than the French. The high state of training of the German soldiers led to asymmetry in proficiency. These two factors combined created a tremendous psychological asymmetry. The combination of these three subordinate asymmetries (doctrine, proficiency, psychology) created an operational level asymmetry which resulted in a resounding victory for the Germans.[4]

Subordinate asymmetries seldom act in isolation. It is also true that asymmetry is not a permanent condition. The temptation exists, however, to try to assess asymmetries in isolation and as permanent factors (if for no other reason than simplicity). This is especially true of technological asymmetry.

Technological asymmetry is seemingly a special case because "war is completely permeated by technology and governed by it."[5] Military technological progress is now decisive to the outcome of wars, and has been since the 19th Century.[6] Yet, creating technological

asymmetry is not a straightforward process. Asymmetries are difficult to create without a potential enemy to measure oneself against. Indeed, the very definition of the term implies a counterbalance. Because of the pre-eminence of technology in war, technological superiority can be viewed as a "stand alone" asymmetry. If a power attains a preeminent technological position, and thereafter, maintains a constant, steady improvement, it will, by definition, retain its technological superiority. In reality, however, the result will be asymmetry <u>with itself</u> - and that does not necessarily lead to asymmetry with one's enemies.

While it would seem possible to create a single asymmetry so extreme as to be insurmountable by any potential opponent, such an aspiration is fraught with danger. A dependence upon technology, especially, implies a continuous, steady expenditure of capital, labor, and research in order to maintain a "cushion" large enough to deter or defeat potential enemies. Technological progress, however, seldom occurs at such a steady pace. There are inevitable peaks and valleys of creativity and production, caused by many different factors, not the least of which are budgets.

In spite of the inherent danger of assessing technology in isolation, if war is, indeed, governed by technology, then the case of technological asymmetry is still deserving of special study. Technology governs

war because it multiplies the output of mind and muscle. It may be an exaggeration to say that the first human to sharpen a stone into an axe began the journey to computers and nuclear weapons, but there is a modicum of truth in the assertion. It is true, however, that the real marriage of technology and warfare did not occur until the 19th Century, and the <u>systematic</u> exploitation of science and technology by nations for military purposes did not begin in earnest until World War II.

This connection between science, technology, and warfare is taken for granted by modern military forces and is based upon a kind of faith in the necessity of technological progress. This faith in technological progress has as its foundation objective, physical nature. Technology is a linear function where outcomes are proportional to inputs, and where what works today will also work tomorrow. When technology is subjected to organization, it leads to systems of machines, which are also systems of linear relationships. The key characteristics of technology can thus be summarized as direct linkage between cause and effect, repetitiveness, specialization, integration, certainty, and efficiency. When applied to military problems, technology provides capabilities which are actualized into missions, and the logical conclusion is that technological superiority wins wars.[7]

These characteristics of technology also make clear the reason technological asymmetry does not always lead to victory, and why there can be such a thing as an over-reliance on technological dominance. The logic of technology holds that efficiency directly correlates with effectiveness. The logic of war is directly opposite - efficiency may result in complete ineffectiveness. The concept of technological superiority is often regarded simply as accumulating "bigger and better" weapons. The above discussion shows, however, that this view is somewhat misleading and that gaining technological superiority is more complex than it appears. The best technologies exploit enemy weaknesses while screening enemy strengths. The concept of superiority in an absolute sense is problematic at best, and perhaps impossible.[8]

The quest for absolute technological asymmetry is problematic because war is a contest between two players with independent will. Thus, because an opponent is capable of learning, a given input will not always yield the same output. An action will not succeed a second time precisely because it succeeded the first time. Furthermore, if war was fully consistent with the logic of technology, there would be no reason to fight at all, since the outcome could be calculated in advance. Uncertainty is not only an inherent condition, it is a necessary condition of war. Therefore, "in armed conflict no success is

possible...which is not grounded in an ability to tolerate uncertainty, cope with it, and make use of it."[9]

This study examines the question of whether the United States Air Force (USAF) is too reliant upon technological asymmetry. It examines possible paths to over-reliance and then surveys Air Force doctrine and air power theory. It then assesses that doctrine and theory in light of potential over-reliance on technological asymmetry. The comparison of theory and doctrine with the definitions of over-reliance will provide a foundation for an appropriate conclusion.

TECHNOLOGICAL ASYMMETRY AND OVER-RELIANCE

Because of the paradox between the logic of war and the logic of technology, it is possible to become too reliant upon technological asymmetry in the quest for military victory. For the purposes of this study, four possible paths to over-reliance on technology are proposed. First, a military force is too dependent upon technological asymmetry if human decision making becomes secondary or subservient to machine decision making. Human beings must be the primary decision makers in conflict because war is an act of human action and counteraction. The logic of technology is linear. The logic of humans is not necessarily so, and if one's enemy is indeed human, technology's linear logic will often prove inadequate or even dangerous.

The question of replacing human decision makers with machines is, however, not as straightforward as it appears. The following example illustrates the linearity of technology and its impact on human decision makers.

At 0654Z on 3 July 1988 the US Navy ship *Vincennes* shot down Iran Air Flight 655 over the Persian Gulf using two SM-2 surface to air missiles. There were no survivors among the 290 passengers and crew members aboard the Airbus 300. The *Vincennes* was part of a naval force attempting to protect commercial shipping in the region from the effects of the Iran-Iraq War.[10]

The *Vincennes* is an antiair warfare cruiser (*Ticonderoga*-class) equipped with the Navy's newest air defense system, known as AEGIS, and initial speculation focussed on this technology. Questions were raised regarding how it could possibly identify an Airbus as a threat and whether it automatically fired on the aircraft without human intervention.[11] These questions were completely off the mark in explaining this accidental shootdown, but there was a significant element of machine decision making present in the incident.

The Navy's investigation of the events of 3 July 1988 concluded that it was human error, not technological error, which led to the downing of the airliner. There was no independent action by the technology of the AEGIS system. Yet, this incident

illustrates a far more insidious form of technology as decision maker - one to which all military technology is susceptible and for which there may be no solution.

Captain Will Rogers' decision to fire was based on 15 discernible indicators that the unknown target was hostile and presented a threat to his ship. Most of the 15 decision indicators were somewhat ambiguous, and two were completely incorrect. The aircraft was reported in the Combat Information Center (CIC) as descending and squawking a Mode II IFF code which had been previously correlated with Iranian F-14s. The aircraft was, in fact, ascending and squawking a civilian Mode III IFF code. The AEGIS system showed the correct information throughout the engagement.[12] The captain, rather than absorbing tactical information from the large screen displays in the CIC, relied upon interpretations of that information passed to him by his tactical team.[13] His decision to fire was based upon those interpretations, but was also forced upon him by technological factors.

The captain was forced to fire by the technology of his own and his presumed opponent's weapon systems. The SM-2 missiles fired by the *Vincennes* must arm themselves during the flight to their target. They, therefore, must be fired before the target is too close. (The exact range for the SM-2 missiles is classified. *Vincennes* fired her missiles when the target was 10 miles distant.) Similarly, given that

the crew thought they were facing a hostile F-14, the firing decision was also forced by the vulnerability of the *Vincennes* to the aircraft's potential air-to-surface missile threat.[14] Consequently, even though the facts remained ambiguous throughout the engagement, the weapon system technology replaced the human decision maker by forcing his hand.

This form of technology as decision maker is insidious and likely to be unrecognized or not acknowledged. It is also widespread because there are always limits to the capabilities of even the most sophisticated systems. Further exacerbating the problem is the manner in which these systems interact, and the effects of the natural environment. When interconnected systems have different technological limits, and when those limits can be changed by environmental factors, military leaders can find themselves forced to make a decision by the nature of the technology.

In the case of the *Vincennes*, the sensor technology was limited by an inability to positively identify the threat. The defensive weapons technology was limited by its range envelope. The captain's decision window was also limited by the constrained geography of the Persian Gulf region.[15] The interaction of these limits forced a decision which resulted in a civilian airliner being shot down.

It can be argued there is never perfect information on the battlefield and commanders are always constrained by limits of one kind or another - and this is true. The importance of this particular example rests in the illustration of the built-in decisions inherent in even the most advanced technologies. There may be no way to avoid them (we may not want to), but surely there is an advantage in recognizing them for what they are.

The second path to over-reliance on technology occurs when it takes the place of tactics, operational art, or strategy. Technology is a tool of tactics, operational art, and strategy, not a replacement for them. When technology becomes such a replacement, tactics, operations, and strategies are adopted simply because they can be accomplished, rather than because they serve some ultimate purpose. The course of action pursued by the United States during the Vietnam War is illustrative of this concept.

When technology replaces strategy, a nation effectively severs the links between military action, military objectives, and political objectives. The effects of this technological replacement can reach the highest levels of military and political decision making. The foreign policy of the United States has contained a significant technological element since World War II. Dr. Henry Kissinger has noted that since that war, US foreign policy has been based "on the

assumption that technology plus managerial skills gave us the ability to reshape the international system and to bring domestic transformations in 'emerging countries.'"[16]

When faced with the need to create a "domestic transformation" in the "emerging country" of South Vietnam, it was logical for the US to rely on its superiority in technological and managerial skills. This technological and managerial excellence would be applied to both the South Vietnamese ally and the North Vietnamese/Viet Cong enemy. US political and military leaders perceived the ally and the enemy as mirror-images, only less capable. Victory was, therefore, inevitable. US strategy and success, and South Vietnamese failure became the products of technical forces which could be measured quantitatively and applied efficiently.[17] Technology, rather than serving as a tool of strategy, replaced strategy.

Technology became a force substitute rather than merely a force multiplier, and the primary vehicle for achieving this force substitution was the concept of airmobile operations. Airmobile operations rested upon a single technology - the helicopter.[18] The armed helicopter subsequently determined the nature of the Vietnam War and was essential to its conduct.[19]

In reality, however, airmobile operations were a tacit admission that the US did not, and could not, control the ground. Because airmobile technology

became strategy, there was no incentive to think through the problem of controlling the ground. It was "wished away" as unimportant because the enemy would be defeated by using the speed of airmobile operations to find him and strike him before he could get away. General William C. Westmoreland, COMUSMACV, regarded the helicopter and US firepower as a counterbalance to the inhospitable terrain and the enemy's propensity to operate in remote regions.[20]

Westmoreland's predecessor, General Paul D. Harkins, recognized the technological trap represented by the airmobile strategy, but seemed unable to avoid it. S.L.A. Marshall relates the following conversation regarding airmobile operations which took place between Harkins and him in 1962.

> Marshall: You know it will not work...There are too few spots approximate to [Viet Cong] base camps where choppers can be put down. So they will draw in the ARVN to a present defense where the birds will be shot up and the soldiers dispersed before they can deploy. Ambush will follow ambush.
>
> Harkins: I can see it coming, but what can be done about it?[21]

Marshall's picture of the future was essentially correct, even though at times, US forces successfully brought to battle large Viet Cong or NVA units using the speed of the helicopter. These tactical successes were immaterial since the strategy of technology provided no overarching military or political objectives.

The Vietnam War has become one the most analyzed events in US military and political history, and it cannot be said there is any "grand consensus" regarding the conclusions to be drawn. While there is a recognition that technology was viewed (incorrectly) by some as a panacea, there are no generally agreed upon "technological lessons learned." There is, however, evidence to support the idea that airmobile technology replaced strategy as the foundation for fighting the war. It is an appropriate example for illustrating the pitfalls of allowing this to happen.

A third indicator that a military force is too reliant upon technological asymmetry is evident if a requirement for the success of its technology is the elimination of fog and friction (i.e. the attainment of perfect knowledge). This can take place on the tactical, operational, or strategic level of war.

The nature of precision munitions provides a simple example. Cruise missiles depend on a combination of inertial reference, terrain contour mapping, and visual reference for navigation. The accumulation and programming of the information can take weeks or even months. Since the missile flies to a point and blows up, the navigation information must be nearly perfect to achieve the desired level of precision. Cruise missiles and other types of precision munitions are vulnerable to jamming and random signals as well as passive countermeasures and

the potential for mutual interference.[22] These types of degradations are particularly debilitating because the munitions must operate nearly perfectly in order to fulfill mission requirements. The normal fog and friction of war must be eliminated to meet these expectations.

The elimination of fog and friction is not attainable because human beings are an inherent part of any weapon system and because it is impossible to anticipate the myriad ways fog and friction may influence weapons technology. Human beings are subject to the effects of stress, fatigue, anger, and a myriad of other emotions and psychological effects which make their actions unpredictable. The best technology in the world cannot anticipate the degradations caused by fog and friction.

The final path to over-reliance on technology is indicated if the success of the technology is dependent upon an assumed enemy response or capability. For the reasons listed above (fatigue, stress, anger, etc.), it is impossible to develop a finite list of possible enemy actions and reactions. Any technology which depends upon such a list, is subject to failure based upon an inability to anticipate. Additionally, enemy capabilities are bound to change, and in ways that may be difficult to anticipate.

For example, the success of so-called Stealth technology depends entirely upon an enemy's reliance on

radar for detection. Research is already proceeding in at least one world power on stealth countermeasures including electrothermal guns, electromagnetic launchers, neutral particle beam systems, various lasers, charged particle beams, and ultra-wide band radars.[23]

The success of any military technology is dependent on an assumed enemy response, at least to a degree. The normal evolution of technical advances and subsequent countermeasures is proof of this. It is in the degree of commitment to a particular technology that military forces err - "putting all one's eggs in one basket" as it were. A second source of error in this regard occurs on a "macro" level when military forces become dependent on technology to the virtual exclusion of the human factors of warfare. In doing so, they must rely on a similarly technologically dependent enemy in order to insure their own success.

THE US AIR FORCE AND TECHNOLOGICAL ASYMMETRY

The US Air Force view of the importance of technological asymmetry had its genesis in the turmoil of thinking that took place between WW I and WW II. Air power thinkers such as Guilio Douhet and Billy Mitchell created a theory of air power application which was almost solely dependent upon technological asymmetry. The theory and dependence are essentially unchanged to this day.

Douhet's guiding premise was that of technology as the most important element of war. For him, the choice of targets became the essence of strategy. His was a mechanistic view with little regard for the potential actions and reactions of the enemy. Mitchell's argument was also shaped by technical considerations. He asserted that aircraft offered the opportunity to achieve victory without the requirement to defeat land armies. This would require as a consequence new rules for the conduct of war and new ideas about strategy.[24] The early air power thinkers took as a guiding premise the need for technological asymmetry.

The foundation provided by Douhet and Mitchell was seized upon by the Army Air Corps as its *raison d'etre* and its justification for independence as a service. By the mid-1930s, instructors at the Air Corps Tactical School (ACTS) had translated this foundation into the doctrine of daylight high-altitude precision bombing directed at so-called "bottleneck" targets.

This doctrine was based upon three interlocking principles. First, modern states would cease to function if vital elements of their economic systems could be destroyed.[25] Second, sufficient precision was available to enable one to strike these vital elements. And third, the bombers conducting the strikes would always get through to their targets. The foundation of this thinking was technological asymmetry. Given these principles, ACTS doctrine on the eve of WW II was based

on the following key elements. The most efficient means of defeating an enemy was aerial bombardment of his war-making capacity. Scientific analysis would identify those elements the destruction of which would cripple the enemy war machine or will. Precision bombardment which was dependent upon positive identification and pinpoint targeting was possible. Having done this, the enemy would lack the means to continue military action regardless of his remaining land or naval forces.[26]

In the event, however, neither the principles nor the doctrine was viable. David MacIsaac has delineated four major flaws in the ACTS formulation. First was the generally unstated assumption that precise intelligence would be available. Any course of action dependent upon precise targeting is equally dependent upon precise information. The ACTS planners "assumed away" the difficulty of achieving the required precision of intelligence.

The second flaw was the tendency to magnify potential capabilities which were often still on the drawing board and to minimize potential limiting factors. The technological superiority required by this doctrine was also an assumed capability, rather than fact. However, the doctrine was promulgated as if the capabilities were fact.

The third shortcoming consisted of a pattern of looking at parts of the problem at the expense of the

whole. This led to a concentration on the means rather than the ends - the technology of the aircraft. The planners also tended to confuse destruction of a target with control of the target; and they reduced strategy to a targeting problem.

The final, and almost fatal flaw, was the assumption that the bombers would always get through. The planners grossly overestimated the self-defense capabilities of the bombers. One is forced to wonder at their faith in the technological enhancement of the bomber and their dismissal of the possibility of technological advances in fighter aircraft and other defenses.[27]

While these flaws are identifiable in hindsight, the results of the European and Pacific strategic bombing campaigns were sufficiently ambiguous to provide validation of the doctrine - at least in the eyes of some. The post-WW II United States Air Force continued the doctrinal focus on strategic bombardment as its primary mission and technological asymmetry to accomplish that mission. Technological asymmetry was to be achieved by insuring science served the needs of the military.

World War II marked a watershed in the relationship between science, technology, and warfare. Major scientific contributions to the war effort included radar, the proximity fuse, jet propulsion, practical rocket weapons, improved bombsights,

penicillin, insecticides and rodenticides, packaging of blood and blood substitutes, special purpose vehicles (land and sea), and, of course, atomic weapons. This list not only serves to illustrate a quantitative increase in the interaction between science and the military, but also a qualitative difference in the relationship.[28] The air, in particular, was a technological environment.

World War II saw the advent of purposeful application of scientific and technical research to military problems. Science was integrated into the war effort by the simple expedient of hiring the scientists - either directly into government service or as government contractors. Military laboratories, defense industries, and university faculties "cross-pollinated" each other in the quest for technological superiority. This effort was perceived to be so successful that military leaders drew the conclusion that superior scientific and technical ability would be harbingers of victory.[29] The Army Air Force was particularly enamored of this technological asymmetry.

This conclusion led to a post-World War II emphasis on the quality of weapons and technology as the determinant of victory. The ultimate result for the post-war military was a system for methodically surveying science and technology for applicable innovations and the creation of a "military industry" qualitatively different than the old arsenal system.

The Cold War insured the continued importance of the relationship between technology and the military.[30]

The importance of technological superiority has come to dominate military thinking to a large extent, and this is nowhere more true than in the Air Force. The problem for USAF thinkers since World War II has been one of determining when an emphasis on technological asymmetry becomes over-reliance. Unfortunately, the question has seldom been addressed in any detail or with any rigor.

In 1946, the basic school doctrine of the Air University stated that "the ultimate objective of air power is to force the capitulation of an enemy nation by air action against the vital points of its national structure."[31] Post-war doctrine writers deliberately avoided reference to the military theory and history of land warfare. The 1955 version of basic Air Force doctrine continued to regard surface forces as peripheral, and proclaimed the greatest opportunity for the application of air power was the strike at the enemy's heartland.[32]

The latest version of AFM 1-1, while it does take cognizance of the human dimension of war, holds to the same basic "truths."[33] The emphasis on strategic bombardment (now termed "strategic attack") is more subtle, but the details illuminate a direct link to the theories of Douhet, Mitchell, and the Air Corps Tactical School. The theoretical writings of current

air power thinkers as well as the curriculum of the Air Command and Staff College (ACSC) make this link even more pronounced - and the link revolves around technological asymmetry and the same principles which provided the foundation for the theory of daylight high altitude precision bombardment.

A study of the key points of the latest edition of AFM 1-1 Basic Aerospace Doctrine of the United States Air Force yields some interesting results. It begins by discussing war as a product of human endeavor and invoking the Clausewitzian concepts of fog, friction, and chance. It also states that air power does not change the essential nature of war. The subsequent chapters of the manual expand on the basic institutional beliefs of the Air Force regarding the nature and employment of air power.[34]

The manual describes the advantages of air power as the ability to concentrate quickly at any point, and the ability to apply force against any element of enemy power - whether political, economic, military, or social - either simultaneously or individually. It goes on to describe the versatility of being able to strike strategic, operational, or tactical targets at any time and proclaims that joint operations with land or naval forces may create powerful synergies, but that air power may be most effective when employed in parallel or relatively independent campaigns. Precision weapons are described as increasing combat

power because they allow a higher operational tempo, reduce risk, and decrease collateral damage.[35] The manual continues the discussion of employment of air power by explaining the basics of the strategic attack, interdiction, and close air support missions. It is in the description of strategic attack that the link to Douhet, Mitchell, and the ACTS is clear.

Strategic attacks are aimed at an enemy's centers of gravity which are described as command elements, war production assets, and infrastructure (energy, transportation, communications facilities, etc.). These attacks produce effects disproportionately greater than the effort expended to conduct them, and directly affect enemy war-making capability and possibly his will to continue. They "should affect the entire war effort rather than just a single campaign or a single battle." Precision weapons provide greater efficiency of execution.[36]

These statements are essentially identical to the ACTS doctrine of the late 1930s, and the doctrine still suffers from the same basic shortcomings enumerated by MacIsaac. There is still an assumption of the availability of precise intelligence. Technological capabilities are still exaggerated. Strategy is again reduced to a targeting problem. And it is assumed the bombers will always get through to their targets.

While AFM 1-1 takes a somewhat generalized approach to strategic attack, the actual application of

the doctrine as represented in the writings of Colonel John Warden III and as taught at the Air Command and Staff College (the academic descendant of ACTS) is more extreme and thus more subject to error. Colonel Warden's views are important because of his role in designing the air campaign during the Persian Gulf War[37] and because during his tenure as Commandant of ACSC, he has influenced the next generation of air power planners.

Colonel Warden has proposed a theory of strategic warfare which has as its foundation two related elements. The first of these is the idea that it is possible to isolate the physical side of warfare. The second is the analysis of the enemy as a system of subsystems - both are a product of technological asymmetry.

For Warden, strategic warfare arises from the need to design campaigns from the top down. One must first focus on the enemy *in toto*, then one's objective, then how to make the enemy regard that objective as his own objective, and only then can one begin to think about how to produce this desired effect. Strategic warfare implies that the clash of military forces no longer has to be the central feature of war. Such direct military clashes are always a means to an end, not an end in and of themselves. They are not always necessary, and in fact, are better avoided.[38]

Warden's effort to isolate the physical side of warfare results from what he terms the need to "demystify war." He regards the Clausewitzian/ Napoleonic formulation of fog, friction, and the importance of the moral over the physical as no longer valid. This is true because even individual fighters are now dependent on physical things (i.e. technology), without which they are unable to affect the enemy. As a result, Napoleon's famous aphorism declaring the moral to the physical as 3:1 is no longer accurate - the ratio is now coequal, if not weighted toward the physical side.[39]

Warden's views regarding the physical side of war are summarized by the following statements.

> We can now put [fog, friction, and morale] in a distinct category, separate from the physical... we can think broadly about war in the form of an equation:
>
> (Physical) x (Morale) = Outcome
>
> The physical side of the enemy is, in theory, perfectly knowable and predictable ...the morale side...is beyond the realm of the predictable...Our war efforts, therefore, should be directed primarily at the physical side.
>
> The advent of air power and accurate weapons has made it possible to destroy the physical side of the enemy.

He does not mean that morale, fog, and friction have disappeared, but implies that since they are now distinct from the physical, if one drives the physical factor of the equation to zero, the morale factor is essentially, irrelevant.[40]

The second element of Warden's theory depends upon the characterization of the enemy as a system of subsystems to make use of the new physical reality of warfare. To achieve strategic objectives, one causes changes to the enemy's physical side or makes him physically unable to offer opposition, but the key to this is inducing strategic paralysis rather than physical destruction.

Warden proposes a model of strategic entities in order to simplify the process of strategic paralysis. This model is a series of five concentric rings representing, from the innermost ring, central leadership or direction, organic essentials, infrastructure, population, and system protection. According to Warden, even though there are an infinite number of systems, all are effectively described by the model, and even though it is a simplification, it allows for sufficient understanding. The five rings simplify the problem of identifying enemy centers of gravity. The closer one strikes to the innermost ring, the better able one is to achieve strategic paralysis with a minimum of effort, casualties (to both sides), and collateral damage. "The essence of war is applying pressure against the enemy's innermost strategic ring - its command structure...It is pointless to deal with enemy military forces if they can be bypassed by strategy or technology either in the defense or offense."[41]

Warden's view of how this theory should be implemented can be seen in his INSTANT THUNDER campaign briefing to General H. Norman Schwarzkopf on 17 August 1990. His summary of what to expect from executing the plan included the destruction of Saddam Hussein's power base, the degradation of his offensive military capability, leaving it difficult to rebuild, and the severe disruption of his economy, leaving it quickly restorable.

The emphasis of the campaign was on national paralysis and shock, and a primary objective was to minimize casualties, including civilians. Examples of the targeting analysis included in Warden's plan were the proposed strikes against the Ajaji power plant and the Al Basrah and Az Yubayr oil refineries. The power plant switching grid was to be struck by B-52s and Tomahawk Land Attack Missiles (TLAMs). Such a strike would reduce total electrical power production by 13%, and reduce Baghdad's supply to 40% of its requirement. The strikes of the refineries would be focussed on the cracking towers so as to critically reduce the internal flow of oil during the war, but allow for quick recovery after the end of hostilities.[42] Warden was able to apply his theory of strategic paralysis to the development of the Gulf War air campaign.

However, he is not the only USAF proponent of air power theories which are dependent upon technological asymmetry. There are two indicators of how widespread

these ideas are. The first is their presentation at the Air Command and Staff College. The second is the publication of similar theories in the Air Force's professional journal (Air power Journal).[43]

The ACSC curriculum was completely revised effective with the 1993-94 academic year at the direction of Colonel Warden. The revision was intended to capture the spirit of ACTS while avoiding its failings. It took as its departure point the idea that DESERT STORM provided validation of Douhet's concepts regarding the application of air power. The air element was equal with the land and sea elements for the first time in history.[44]

The curriculum is divided into ten interrelated blocks of instruction which build from the general to the specific. While the course is not limited solely to Warden's ideas, his influence is unmistakable in at least five of the blocks.

The military theory block is described as providing a systematic analysis of warfare with a view toward providing the students the tools necessary to develop military theory relevant to the 21st Century. "The reformation of military theory, and the creation of new paradigms, is the first critical step in integrating new technology into war fighting."[45]

The strategic structure block focuses on strategic level organization and centers of gravity. It "applies strategic organization theory to states, sub-states,

and criminal entities and shows the exploitable similarities among all of them." The operational structure block then focuses on identification and targeting of enemy operational centers of gravity.[46]

The subsequent air campaign block "explores the military technological revolution critically examining the concept, the technological and operational reality behind it, its effects on warfare." And the campaign 2000+ block "applies analysis of the lessons of history to our need to stay a 'technological revolution' ahead of the rest of the world."[47]

The influence of Colonel Warden and his theory of strategic warfare is clearly evident in these brief descriptions. The curriculum is focused on strategic attack, the enemy as a system, the physical side of warfare, and technological asymmetry.[48] These ideas have also gained widespread publication in the pages of Air power Journal in the words of many different authors.

A survey of Air power Journal articles since the end of DESERT STORM reveals an outpouring of thought on the perceived validation of air power as a decisive element of war. While the authors are not all in complete agreement with Warden, there is a consistent focus on the efficacy of strategic attack and the need for technological asymmetry. Two articles illustrate the spectrum of views and the underlying assumptions.

The first is illustrative of the emphasis on technological asymmetry. The author, Price T. Bingham (a retired USAF lieutenant colonel and frequent contributor to Air power Journal), asserts that technological change has brought a revolution in warfare, and air power is the vehicle of that change. He further claims that anyone who refuses to accept this is operating from an obsolete conception of conventional warfare.

He goes on to say that early air power (through WW II) suffered from technical limits. DESERT STORM showed that we have now essentially overcome those limits through more advanced technology. The Iraqis could not fight back because Stealth, suppressive technologies, and other technical advances rendered their air defenses ineffective. DESERT STORM also indicates that the proper role for land forces is in support of air forces, which are now the primary tool for destroying land armies.[49]

The second article illustrates another author's conception of strategic attack, which is essentially congruent with Warden's. Jason B. Barlow (a USAF major and graduate of the School of Advanced Air power Studies) describes strategic paralysis as an independent strategy for the application of air power. The strategy is focused on national-level targets which directly support the enemy will and capability to make

war, and holds the potential for changing enemy behavior at a relatively low cost.

The success of strategic paralysis is dependent upon four key elements: aerospace control (air superiority), technology (precision guided munitions, cruise missiles, global positioning system, and stealth which provide the penetration, persistence, and weaponry necessary for direct attack of strategic centers), a vulnerable infrastructure (which is readily found in a modern, industrialized state), and vital targets.[50]

Barlow says "target selection lies at the heart of military doctrine and theory." He describes vital targets as "national elements of value (NEV)," the destruction of which can paralyze an enemy government. There are seven noteworthy NEVs (of varying relative importance) available for targeting in any country - leadership, industry, armed forces, population, transportation, communication, and alliances.[51]

In order to make the targeting of NEVs "work," one must understand the enemy's "rationality" - target what he values and know what he regards as unacceptable losses.

> A rational enemy will give up only when the costs of continuing the conflict outweigh any potential benefits. Air power's toughest challenge...may be in educating future adversaries in the fact that loss of the air means loss of the conflict.[52]

Barlow identifies potential limitations on strategic paralysis as loss of the required technical

advantage and loss of aerospace control. He concludes by noting that it is not appropriate to every situation, but is appealing to any country seeking quick victory at low cost and those who want to minimize civilian and military casualties. He regards it as definitely suited to the United States.[53]

Bingham and Barlow represent a spectrum of views typical of authors writing for Air power Journal on the subject of Air Force doctrine and the proper employment of air power.[54] While the exact formulations may change, there is a consistent reliance on technological asymmetry. Examination of the doctrine and its interpreters and practitioners reveals a number of striking shortcomings which can be analyzed with respect to the four paths to over-reliance on technological asymmetry.

ANALYSIS AND CONCLUSIONS

Regarding the first path to over-reliance, current Air Force theory and doctrine do not advocate replacing human decision makers with technology. Air power thinkers do, however unwittingly, advocate the use of technologies which have an inherent capacity to remove humans from the decision making process. Eliot Cohen explains one means by which this happens.

He points out that electronic information is often perceived as unambiguous, when it is, in fact, imbedded with ambiguities. When information is presented on an

electronic display or by some other electronically advanced means, or is gathered by a technical system, it seems to be granted an inherent credibility by human operators - primarily because the electronics are as yet unable to display or convey the subtleties and nuances of a human messenger. This is often overlooked by human operators, and decisions are made based upon this perceived unambiguous data. Additionally, as these technological information systems are improved, they tend to become systems of information gatherers which are designed to sift and interpret data automatically. The information thus presented becomes an abstraction of reality which, again, may be perceived with less ambiguity than it warrants.[55]

The USAF is particularly susceptible to this form of technological decision making. The effective execution of strategic attack requires an asymmetry of information in favor of the US. The theory requires that information to be absolutely precise and unambiguous, yet, the technological means of acquiring it have inherent, unrecognized ambiguities as described above. The technology replaces human decision makers in a subtle but significant manner, and the asymmetry is founded on the technological decision maker rather than the human decision maker.

Long-range precision munitions also contain another element of technological decision making, especially those designed for "fire and forget"

delivery. These weapons (cruise missiles, for example) eliminate the flexibility inherent in the human decision maker during the munitions delivery phase. The "human in the loop" is removed from the war making process by an order of magnitude in comparison to older "dumb" munitions. Even so-called "brilliant" munitions have no way of pulling up at the last minute because the convoy of trucks which is the target is loaded with civilian refugees rather that soldiers. At the "point of the spear," the technology is making the decision, not human beings. The asymmetry provided by these munitions is dependent on technological decision making.

Current USAF doctrine not only has a built-in technological decision making component, it also has an element of technology as strategy (the second path to over-reliance). Although this is difficult to "prove" empirically, there is at least circumstantial evidence to support it. Barlow, as quoted above, has been the most bold of the the air power thinkers in proclaiming targeting as the essence of doctrine. His description of strategic paralysis centers on identification and destruction of "national elements of value" - in other words, targets. Warden's theory also rests on the technology of targeting and destruction, however selective. Bingham's discussion, as well, is solely concerned with the technology of targeting.

Watts, in his analysis of Air Force doctrine, found that air war was typically reduced to an engineering problem, and that aerial strategy thus took the form of targeting.[56] Targeting is regarded as a technological problem, to be solved by the application of technology. Warden and the others clearly fall into this category of thinking. Rather than broadly focussed strategic analysis, their "strategies" rest on narrowly focussed target analysis. The technology of strategic attack (delivery technologies and analysis of enemy technologies) has replaced true strategic thinking. When technology replaces strategy, the doctrine is over-reliant on technological asymmetry.

The asymmetry of strategic attack also depends to a large degree on the elimination of fog and friction - the third path to over-reliance on technology. Warden says it is possible, through the use of technology, to know the physical side of war and to isolate it from the moral or human side. Both of these assertions are deserving of examination in some detail.

For Warden, the ability to know the physical side rests on his model of the system of subsystems (five rings), which is applicable to any target entity. Barlow's concept of national elements of value is basically the same identification of interacting systems as Warden, without the rings. Even those advocates of strategic attack who forego a conceptual model are still dependent upon identifying and striking

the key nodes of a target state's strategic systems. Regardless of who's concept is used, the key to the success of the technology is perfect or near perfect information about the enemy's strategic systems - in other words the elimination of fog and friction, and this constitutes over-reliance on technological asymmetry.

A brief review of the nature of systems analysis reveals why this is so. Systems analysis is much more difficult than the advocates of strategic attack would seem to indicate. Warden's description of a state as a system of subsystems is accurate, but his assertion that a simple model of those systems is adequate is not.

Charles Perrow has shown that complex systems with multiple interactions among parts, procedures, and operators are subject to unanticipated and unknown interactions. These unanticipated and unknown interactions are inherent characteristics of systems with interactive complexity, and are not within the designers' or operators' capacity to anticipate or know.[57]

When designers and operators are unable to anticipate system interactions, it would seem to be even more difficult for outsiders to do so. Strategic attack, however, is predicated on an ability to do just that. Because the objective is to selectively damage parts of the system in order to cause a particular

effect, planners must have precise knowledge and understanding of the target systems in order to make the strategy viable.

Perrow shows that this is not possible. Strategic attack and Warden's assumption of one's ability to know the physical side of war are based on what Perrow calls linear interactions. Linear interactions are those between the components of a system and those immediately preceding or following them in the production sequence. They are visible, expected, anticipated, and familiar. Interruptions of linear interactions lead to component failure accidents, in which one or more failures are linked in an anticipated sequence.

Complex systems, on the other hand, are subject to complex interactions in which there are relationships with components outside the production sequence, either by design or not. These complex interactions are unfamiliar, unplanned, and unexpected, and are not visible nor immediately comprehensible. Interruptions of complex interactions lead to system accidents which result in the unanticipated interactions of multiple failures.[58]

Strategic attack is dependent on the assumption of linear interactions and the ability to cause component failure accidents. Since target systems are more likely to be subject to complex interactions, an attack

will often result in system accidents with unanticipated and possibly unwanted outcomes.

For example, on the night of 12-13 February 1991, USAF F-117s attacked the Al Firdos bunker located in suburban Baghdad. The bunker was one of a series of leadership targets identified by air planners. When intelligence sources indicated the bunker was in use, commanders ordered the strike. The morning following the attack, the Iraqis claimed, and CNN reported, the upper levels of the bunker were in use as an air raid shelter, and that 200-300 civilians, including 100 children, had died. As a result, strikes against such leadership targets were significantly reduced and General Schwarzkopf personally reviewed targets in downtown Baghdad.[59]

The planners anticipated a linear interaction between the strike, the bunker, and the Iraqi leadership. The result was, instead, a complex interaction between the strike, the civilians, and US leadership. The outcome was unanticipated and apparently unknowable - and this is a relatively simple example of complex interactions. The presumption of system knowledge inherent to strategic attack is thus much more problematic than adherents would seem to believe. The ability to cause desired effects while preventing those which are undesired is inherently limited by the nature of complex systems. The inherent complexity of systems is another source of fog and

friction. The advocates of strategic attack assume they can obtain the systems knowledge necessary to eliminate this fog and friction. The example illustrates how difficult this is.

The example also shows that systems complexity is relevant to analysis of the interactions of friendly forces. The technology of warfare significantly alters the nature of military organizations. Assumptions about and requirements of the technology affect and drive plans, people, and places. The interactions of organization, environment, and tools can cause unexplainable and unanticipated outcomes.[60]

This complexity produces surprise. Unforeseen outcomes result when minor variations lead to some unpredictable total.[61] Organizations typically react to these unpredictable results by adding more complexity (e.g. reviewing targets at a higher command level), thereby exacerbating the problem rather than solving it.[62] The interactions among and between friendly and enemy systems is inherently complex and is not knowable to the degree posited by the advocates of strategic attack.[63] The USAF's focus on achieving technological asymmetry by eliminating fog and friction constitutes over-reliance.

The final measure of over-reliance on technological asymmetry rests on whether the success of the technology depends upon an assumption of how the enemy will react. The proponents of strategic attack

make such an assumption - on two levels. First, they depend on the the technology of precision munitions which allows them to carefully calculate effects and limit collateral damage. In doing so, they assume the enemy will react in the manner anticipated, and the success of such attacks depends on that reaction. Second, the dependence on an overly simplified model of the systems to be attacked drives strategic attacker advocates toward an assumption that the effect of the attacks will be as predicted. They ignore the human element because it is presumed to be irrelevant. The enemy is assumed to be as dependent on technology as the US; therefore, the US can use a technical advantage to remove his means of reaction.

The weakness of this approach revolves around the necessity to separate the physical from the human elements of war and a simplified view of systems. Perrow notes that "humans are part of all...systems" and must be included in any analysis.[64] In calculating the effects of strategic attack, some advocates take an absolute rationalist approach to analysis of the enemy's reactions. Absolute rationality is the approach of economists and engineers and depends on narrow, quantitative calculations regarding risks and benefits applied to the achieving of precise goals. In a human-led system, however, there is another form of rationality at work - social (or cultural) rationality. Social rationality operates outside the bounds of

absolute rationality and may lead to unquantifiable reactions or reactions which defy the "normal logic" of rationality.[65] For example, in 1870 the French lost the bulk of their army and the head of state to the Prussians, but the nation continued the conflict.[66] Absolute rationality would seem to dictate surrender after such devastating losses - social rationality dictated otherwise. Only absolute rationality permits an accurate prediction of enemy response. The success of the technology of strategic attack depends on that prediction, but the workings of social rationality do not permit it. This also constitutes over-reliance on technological asymmetry.

Other air power advocates would say the rationality of the enemy is irrelevant because strategic attack will deprive the enemy of the means of response. Even in this view, the success of the technology is dependent upon a particular enemy response - in this case a "zero" response. A zero response, in turn, presumes a degree of technological asymmetry seldom achieved.

The Gulf War may have been a case of such asymmetry, but Robert Spulak explains why this will continue to be rare. He notes that in seeking to bypass fielded enemy forces and induce strategic paralysis, the advocates of strategic attack are, in essence, seeking to convince the enemy he is defeated rather that physically defeating his armed forces.

This may be possible in theory, and occasionally in reality, but is dependent upon several critical factors which may not always hold true.[67]

The question of strategic paralysis hinges on an assessment of the "pain level" the enemy is capable of accepting, what level they can accept and still function, and whether the fielded military forces will still act if severed from the political leadership. It is also dependent upon knowledge: of target locations, of the accuracy of the strikes, and of the effectiveness of various weapons against each target. The final factor which impacts the ability to inflict strategic paralysis is the degree of resilience inherent in the enemy system and the ability to make accommodations or repairs to the damage.[68] The technological asymmetry necessary to satisfy the above conditions may be attainable against only a small number of potential enemies.

The above analysis constitutes a preponderance of support for the conclusion that the USAF is, indeed, too dependent upon technological asymmetry. There is an element of technology replacing human decision makers inherent in the process of gathering and disseminating the information required to conduct strategic attack and in the use of long-range precision munitions. Current USAF theory and doctrine is also over-reliant on technological asymmetry because, at least to a degree, technology has replaced strategy.

Strategic attack also constitutes over-reliance on technological asymmetry in its requirement to eliminate the fog and friction of war in order to be effective. The fog and friction may be of a different kind than that experienced by Clausewitz, but it is, nevertheless, still present. The inability to eliminate these two factors which make real war different from war on paper, holds out the probability of serious difficulty when the theory of strategic attack moves from paper to actual implementation.

Finally, air power theorists are over-reliant on technological asymmetry in their assumptions about how an enemy will react to the application of their concept of warfare. Built-in but unknowable resiliencies, plus the vagaries of human nature, make it likely that even if the technology works as advertised, it may not dictate the reaction which is desired.

Watts looked at air power doctrine and concluded that the core beliefs of that doctrine consistently contained a deterministic, mechanistic foundation and an inherent reluctance to credit the influence of friction in this most human of endeavors. He regards this view as fundamentally mistaken because "war is so unruly a phenomenon that total knowledge of its processes is seldom possible even long after the fact, much less at the time."[69]

A deterministic approach has tremendous theoretical appeal. The new air power theorists of

strategic attack have taken such an approach and presented it as the solution to the US problem of winning wars quickly, decisively, and with minimum casualties. Cohen has noted, however, that "air power is an unusually seductive form of military strength, in part because, like modern courtship, it appears to offer gratification without commitment."[70] The appearance of gratification offered by strategic attack is based upon an unacknowledged over-reliance on technological asymmetry. In reality "the extent to which friction pervades the elemental processes of actual combat suggests that the range of situations in which...superior weapons <u>guarantee</u> victory is relatively limited."[71] The assumptions upon which the ideal of strategic attack is based require careful and rigorous examination. Over-reliance on technological asymmetry raises fundamental concerns regarding current USAF theory and doctrine. USAF thinkers must address these concerns in order to make that theory and doctrine truly viable.

ENDNOTES

1. Carl von Clausewitz, On War, ed. and trans. Michael Howard and Peter Paret (Princeton: Princeton University Press, 1976), p. 75.

2. The Random House College Dictionary, rev. ed. (1975), S.v. "asymmetry," "symmetry."

3. A representative engagement is the battle of Omdurman, 1 Sep 1898, between British soldiers and Egyptian infantry and the forces of the Mahdi of Sudan. the British force of 26,000 men defeated the Mahdi's force of perhaps 50,000 at the cost of 48 dead and 382 wounded. Native casualties were approximately 10,800 dead, 16,0000 wounded. Thomas Pakenham, The Scramble for Africa: White Man's Conquest of the Dark Continent from 1876 to 1912 (New York: Avon Books, 1991), pp. 539-40, 542-6.

4. See Barry R. Posen, The Sources of Military Doctrine: France, Britain, and Germany Between the World Wars (Ithaca, NY: Cornell University Press, 1984) and Alistair Horne, To Lose a Battle: France 1940 (New York: Penguin Books, 1990).

5. Martin van Creveld, Technology and War: From 2000 B.C. to the Present (New York: Free Press, 1991), p. 1.

6. Ibid., p. 219.

7. Creveld, pp. 3, 225, 314-5.

8. Ibid., pp. 318-20.

9. Ibid., p. 316.

10. "Formal Investigation into the Downing of Iran Air Flight 655 on 3 July 1988," (Washington, DC: Department of Defense, 19 August 1988), pp. 4, 6. (Hereafter referred to as "Vincennes report.")

11. Will and Sharon Rogers, with Gene Gregson, Storm Center: The USS *Vincennes* and Iran Air Flight 655 (Annapolis: Naval Institute Press, 1992), pp. 2, 68.

12. Ibid., pp. 21, 35, 38.

13. The chain of events leading to the shootdown and the possible reasons for misinterpretation of the tactical data by the CIC team are fascinating, and indicative of another class of potential problems with reliance upon technology, but are not germane to this discussion. The reader is referred to the Vincennes

report for the findings of the investigation board regarding this issue.

Additionally, the commanding officer of USS *Sides*, which was also involved in the tactical action of 3 July 1988 has raised a number of interesting points regarding the shootdown. He characterized the crew of the *Vincennes* as unrestrained and "consistently aggressive." He also proposed a general atmosphere of wanting to prove the worth of the Aegis technology as contributing to the decision making errors. See David R. Carlson, "Comment and Discussion," U.S. Naval Institute Proceedings, September 1989, pp. 87-9, 92. His commentary provoked a firestorm of discussion which continued for six months. See "Comment and Discussion" in Proceedings, Nov 89 through Apr 90.

14. Vincennes report, p. 38 and 2d endorsement to Vincennes report (CJCS), p. 5.

15. Vincennes report, p. 49.

16. Henry A. Kissinger, American Foreign Policy (New York: W.W. Norton, 1974), p. 57.

17. James William Gibson, The Perfect War: Technowar in Vietnam (Boston: Atlantic Monthly Press, 1986), p. 23.

18. Edgar C. Doleman, Tools of War (Boston: Boston Publishing Company, 1984), p. 165; Frederic A. Bergerson, The Army Gets an Air Force: Tactics of Insurgent Bureaucratic Politics (Baltimore: Johns Hopkins University Press, 1980), p. 68.

19. Bergerson, pp. 119, 121.

20. Gibson, p. 105; William C. Westmoreland, "A Military War of Attrition," in The Lessons of Vietnam, ed. W. Scott Thompson and Donaldson D. Frizzell (New York: Crane, Russak and Company, 1977), p. 65.

21. S.L.A. Marshall, "Thoughts on Vietnam" in Thompson and Frizzell, pp. 48-9.

22. Steve Froggett, "Tomahawk in the Desert," U.S. Naval Institute Proceedings, January 1992, p. 73; John G. Roos, "A Pair of Achilles' Heels," Armed Forces Journal International, November 1994, p. 21; Marvin N. Cohen, "Target Recognition for Autonomous Smart Munitions," Journal of Electronic Defense, July 1990, p. 42.

23. Barbara Starr, et al, "After the Storm," Jane's Defence Weekly, 6 April 1991, p. 532.

24. Barry D. Watts, The Foundations of US Air Doctrine: The Problem of Friction in War (Maxwell AFB, AL: Air University Press, 1984), pp. 6-7, 7-11.

See David MacIsaac, "Voices From the Central Blue: The Air Power Theorists," in Makers of Modern Strategy: From Machiavelli to the Nuclear Age, ed. Peter Paret (Princeton: Princeton University Press, 1986), p. 631 for a somewhat different view of Mitchell's contribution to air power thinking. MacIsaac credits Alfred Hurley's view that Mitchell was a crusader rather than original thinker.

25. Watts, in an endnote on p. 25, points out that Muir Fairchild, in an ACTS lecture titled "Air Power and the City," claimed that he could bring an entire city to a halt with 18 bombers. He based this claim on an analysis of a power outage in New York City in 1935. This tidbit bears an uncanny resemblance to Colonel John Warden's claim of 12 critical targets to bring the entire US to its knees - based on targeting science and extrapolation from the power outage in the northeastern US in 1977 which was caused by one faulty relay.

26. Watts, p. 18.

27. MacIsaac, p. 635.

28. Melvin Kranzberg, "Science-Technology and Warfare: Action, Reaction, and Interaction in the Post-World War II Era," in Science, Technology, and Warfare, eds. Monte D. Wright and Lawrence J. Paszek (Washington, DC: Office of Air Force History, 1969), pp. 123, 127.

29. Ibid., pp. 165, 128; James William Gibson, The Perfect War: Technowar in Vietnam (Boston: The Atlantic Monthly Press, 1986), pp. 13-4.

30. Kranzberg, pp. 128, 156. See also Fred Kaplan, The Wizards of Armageddon (Stanford, CA: Stanford University Press, 1991), particularly Chapter 5 which describes the evolution from WW II operations analysis to the post-war genesis of the RAND Corporation.

31. Robert Frank Futrell, Ideas, Concepts, Doctrine: Basic Thinking in the United States Air Force, Vol I, 1907-1960 (Maxwell AFB, AL: Air University Press, 1989), pp. 365-6.

32. Futrell, Vol II, 1961-1984, pp. 711-2.

33. It is not the intent of this study to provide more than a cursory overview of the historical evolution of Air Force doctrine. For an in-depth analysis, the reader is referred to Futrell's two

volumes. See also U.S. Air Force, AFM 1-1 Functions and Basic Doctrine of the United States Air Force (Washington, DC: Department of the Air Force, 1984), Annex A for a brief description of the evolution of the basic doctrine manuals and their contents.

34. U.S. Air Force, AFM 1-1 Basic Aerospace Doctrine of the United States Air Force, Vol I (Washington, DC: Department of the Air Force, 1992), pp. 1, 2, 5. This version of basic doctrine is written in two volumes. The first is described in the Foreword as providing a quick-reference explanation of the "bare bones" of doctrine. Volume II contains a series of essays which provide supporting evidence and rationale for the statements in Volume I. It is unclear whether Volume II is to be regarded as doctrine per se, or not.

35. Ibid., pp. 5, 9, 11.

36. Ibid., pp. 11-12.

37. For a brief review of Warden's role, see Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey Summary Report (Washington, DC: Department of the Air Force, 1993), pp. 35-40.

Richard T. Reynolds' Heart of the Storm: The Genesis of the Air Campaign Against Iraq (Maxwell AFB, AL: Air University Press, 1995) focuses entirely on the planning of the air campaign, particularly the personalities involved and their relative influence.

Several other Gulf War histories mention Warden's planning effort with various degrees of detail, depending on the focus of the author.

The air campaign is in danger of being popularized as proof positive of the efficacy of air power as an independent force capable of winning wars without the requirement for ground combat, thus lending even more credence to Colonel Warden's views.

38. John A. Warden III, "The Enemy As A System," Air power Journal, Spring 1995, p. 42.

39. Ibid., pp. 42-3.

40. Ibid., p. 43.

41. Ibid., pp. 46, 49, 52.

42. Reynolds, pp. 103-5. One might conclude this example does not match the execution of Warden's theory exactly. The example is drawn from work accomplished prior to the publication of his ideas in mature form. It is still sufficient to illustrate the key points.

43. It is impossible to judge the degree of agreement with Col Warden by responses to his published work, since the most recent issue of Air power Journal

is the only readily available published source in which he has expounded on this theory. One can infer agreement based upon articles from other authors expounding the same or similar ideas. An additional indicator is the statement by Major Michael Moeller, USAF that Warden's ideas are used at least in the beginning of the planning/targeting process at the USAF's CHECKMATE planning group. Moeller, presentation to AMSP combined seminar, 30 March 1995, question and answer period.

44. P. Mason Carpenter, and George T. McClain, "Air Command and Staff College Air Campaign Course: The Air Corps Tactical School Reborn?" Air power Journal, Fall 1993, pp. 72, 76-7.

45. Ibid., p. 81.

46. Ibid.

47. Ibid.

48. This view of the focus of the curriculum is supported by Major Steve Goligowski, US Army, current AMSP student and a graduate of the ACSC class of 93-94. Personal conversation with the author 21 April 1995.

49. Price T. Bingham, "The United States Needs to Exploit Its Air Power Advantage," Air power Journal, Fall 1993, pp. 62, 63, 65-6. Bingham may be categorized as a "pre-Warden" thinker.

50. Jason B. Barlow, "Strategic Paralysis: An Air Power Strategy for the Present," Air power Journal, Winter 1993, pp. 5, 6, 7-9. Barlow may be categorized as a disciple of Warden.

51. Ibid., pp. 9-12.

52. Ibid., p. 12

53. Ibid., pp. 12-4.

54. Other representative articles and their key points are listed here.

Price T. Bingham, "Air Power in Desert Storm and the Need for Doctrinal Change, Air power Journal, Winter 1991, pp. 33-46.

- entire US military needs to change doctrine because of air power's decisiveness in Desert Storm

Charles G. Boyd and Charles M. Westenhoff, "Air Power Thinking: 'Request Unrestricted Climb,'" Air power Journal, Fall 1991, pp. 4-15.

- technology has allowed air power to begin to live up to promise
- air power particularly useful in today's uncertain environment because of its responsiveness
- must be careful not to oversell public or national leaders
- a fairly balanced view

Mark Clodfelter, "Of Demons, Storms, and Thunder: A Preliminary Look at Vietnam's Impact on the Persian Gulf Air Campaign," Air power Journal, Winter 1991, pp. 17-32.

- yes, air power was decisive in Desert Storm
- yes, doctrine must be modified (1984 version)
- but Desert Storm cannot be the model, nor can we assume air power always decisive
- another balanced analysis

Dennis M. Drew, "Desert Storm as a Symbol: Implications of the Air War in the Desert," Air power Journal, Fall 1992, pp, 4-13.

- air power has at last fulfilled its promise
- need new way of thinking
- same as Warden - strike strategic centers of gravity without having to fight through fielded forces

Maris McCrabb, "Air Campaign Planning," Air power Journal, Summer 1993, pp. 11-22.

- Warden's ideas, but not just a rote repetition

Phillip S. Meilinger, "The Problem With Our Air Power Doctrine," Air power Journal, Spring 1992, pp. 24-31. (Meilinger served as the first director of the School of Advanced Air power Studies.)

- Gulf War proved decisiveness of air power
- airmen should not be reluctant to embrace this decisiveness
- doctrine should be changed to reflect it

55. Eliot A. Cohen, "The Mystique of U.S. Air Power," Foreign Affairs, Jan-Feb 1994, pp. 113-5.

56. Watts, pp. 46-7.

57. Charles Perrow, Normal Accidents: Living with High-Risk Technologies (New York: Basic Books, 1984), p. 4.

Although this work's primary focus is catastrophic accidents inherent to complex systems, its explanation of how these systems interact is relevant to our

discussion of an inability to understand those interactions, even when our objective is to cause damage to the systems.

58. Ibid., pp. 70, 77-8.

59. Keaney and Cohen, pp. 68-9.

Questions were raised following the reports as to whether there were, in fact, civilians killed in the raid. For the purposes of this discussion, the answer is irrelevant. The reports were broadcast, perceptions were formed, and the US reacted to those perceptions. Therefore, the example is applicable.

60. Chris C. Demchak, Military Organizations, Complex Machines: Modernization in the U.S. Armed Services (Ithaca, NY: Cornell University Press, 1991), p. 3.

61. A physical example of this principle exists in the story, perhaps apocryphal, heard by the author regarding one of the first B-1s delivered to McConnell AFB. It seems this particular aircraft would not fit in the hanger when all the other B-1s did. Investigation revealed that it was 12 inches too long. Further investigation indicated that none of the parts were out of tolerance - rather, many parts were "on the high side" of their tolerances. When these measurements were accumulated, they led to the deviation in the total size of the aircraft.

62. Demchak, pp. 3-5.

63. This brief use of the theory of systems analysis has barely scratched the surface of the subject. The author finds Colonel Warden's theory particularly lacking in this regard and deserving of criticism for his superficial approach to the modeling of systems.

For more information on systems theory, the reader should see F.E. Emery, ed., Systems Thinking (2 vols.) (New York: Penguin Books, 1981), particularly the essays by Feibleman and Friend, Ackoff and Emery, and Sachs (all in Volume I). In Volume II, those by Jordan, Hoos, Rittel and Webber, and Herbst are noteworthy.

For information on the concept of hierarchy in systems (another implied assumption of the strategic attack theorists, particularly Warden), see Richard J. Arras, "A Critical Evaluation of the Concept of Hierarchy" (Ph.D. dissertation, Temple University, 1991).

Gene I. Rochlin and Chris C. Demchak, Lessons of the Gulf War: Ascendant Technology and Declining Capability (Berkeley, CA: Institute of International Studies, 1991) provide an analysis of the Gulf War with respect to organizational complexity, centralized

control, tight coupling, and communication/information needs of military organizations.

Finally, Alan Beyerchen, "Clausewitz, Nonlinearity, and the Unpredictability of War," International Security, Winter 1992/93, pp. 59-90 examines the implications of nonlinearity and even chaos theory in a Clausewitzian context.

64. Perrow, p. 66. This statement was made in the context of the particular systems analyzed by Perrow in this work, but the same can be said of any system designed and constructed by humans, or even those natural systems which interact with humans.

65. Ibid., pp. 315-24.

66. Michael Howard, The Franco-Prussian War: The German Invasion of France, 1870-71 (London: Rupert Hart-Davis, 1962).

67. Robert G. Spulak, Jr., "Strategic Sufficiency and Long-Range Precision Weapons," Strategic Review, Summer 1994, p. 33.

68. Ibid., pp. 34-7.

69. Watts, p. 108.

70. Ibid., p. 113, and Cohen, p. 109.

71. Watts, p. xv.

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